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SECOND OF THE SERIES OF
PIONEERS OF MODERN ANÆSTHESIA.
ALEXANDER WILSON.

THE backward condition of Anæsthesia in London prior to the early eighties, as referred to in the previous article in this series, closely represented the position in the Provinces. As a matter of fact, conditions were much better in London for since the first introduction of anæsthetics in 1847, there had been able men who had devoted themselves to the study and practice of anæsthesia. Snow, Clover, and their contemporaries and successors had, more or less, established the practice of anæsthetics as a specialty, and it had become recognised that the anæsthetist was a necessary member of the staff of every large general hospital. Such recognition contributed considerably to the advancement of the science and art of surgical anæsthesia and made easier the progress of any one embarking upon the practice of this branch of medicine.

In the large provincial surgical centres, such a state of affairs did not obtain. To few, if any, of these hospitals was there attached a special anæsthetist, and the Manchester Royal Infirmary, if not the first, was one of the first to establish such an office and Mr. Alexander Wilson was the first to hold this post.

This advance in the progress of provincial anæsthesia took place in 1886, and the appointment seems to have been created on the initiative of the Lay Board, rather than of the Medical Staff. At the present time this attitude of the Medical Staff is somewhat difficult to understand, but seems to have largely been due to the scanty remuneration attached to the proposed post. This appeared so small that it tacitly put on the Surgical Staff the obligation

of supporting the newcomer out of their private cases. And through long usage almost vested interests had been established in these cases on the part of various individuals, which, naturally, the surgeons were unwilling to disturb.

Mr. A. Wilson, the first holder of the newly-created post, had been a student at the Owens College and the Infirmary and had subsequently held various resident appointments at the Infirmary and other local hospitals and accordingly was *persona grata* to the members of the Staff. Prior to his appointment to the Royal Infirmary, on the two weekly operating days anæsthetics were administered by the two "Physicians' Assistants," medical men whose duty was to attend Out-patients at their own homes. These gentlemen aspired to and ultimately became successful consulting physicians, and their interests being purely medical, they were not particularly interested in surgery or anæsthetics, and their services as anæsthetists were rarely called upon outside the hospital. Urgent operations and those taking place on other days than the official ones were anæsthetised by the junior staff. In private anæsthetics, anæsthetics were given by all and sundry. Failing the general practitioner, the surgeons gave their cases to a house surgeon, junior colleague, or some friend to whom it was desired to do a good turn, for, as indicated in the first article of this series, the giving of an anæsthetic (chloroform) was generally considered a task within the capacity of any one. This system, by which almost every surgeon in his time had given anæsthetics, should have had a beneficial effect and fostered an interest in anæsthesia and developed understanding and sympathy with the difficulties of the anæsthetist. However, so readily are tiresome and even alarming experiences forgotten, that on the whole it had the opposite effect on their careers, so that once the anæsthetist stage was passed and the goal of pure surgery reached, the operator tended to become more impatient with the difficulties of the anæsthetist and opposed to changes of methods than he might otherwise have been. As regards the anæsthetic in vogue, with the exception of nitrous oxide confined to dental work and administered by the dentists, themselves, chloroform, either alone or in mixture as A.C.E, was practically the only one given. This high estimation of the value of chloroform and extreme prejudice against ether is now difficult to understand, and even when allowance is made for the defective manner in which it was then given. However, the fact remains

that surgeons who would tolerate with equanimity almost any untoward circumstance occurring during chloroform anæsthesia, would resent the minor discomforts incidental to even the successful administration of ether. Unfamiliar with any anæsthetic but chloroform this condition did not at first adversely affect Mr. Wilson, and he applied himself to its administration on lint with observation of the pulse and respiration. At the same time the field of anæsthetics seemed so well supplied with workers awaiting advancement in others of medicine that to use a homely simile, a specialist anæsthetist appeared likely to be as much use as the third wheel of a farm cart. There thus being no urgent want to supply, it remained for the newcomer to create a want and this he unconsciously did in virtue of his resource and goodnatured temperament. A Fellow of the English College of Surgeons, he was keenly interested in surgical procedures and was in complete sympathy with the surgeons in all their moods, and was able to be useful in directions outside the strict limit of his official duties. In addition to being an anæsthetist he would lend a free hand in the Out-patient department, teach students instruments, and endeavour to be helpful in some fashion, especially to the house surgeons in their first minor operations. So it gradually came to be recognised that things went more smoothly when Mr. Wilson was there. Especially was this the case in private operations, for in those days nursing homes were few and most operations were done in private houses. Good nurses were scarcer than now and the surgeon did not go to an operation with a highly trained "sister" familar with his ways and bearing an operation kit. Nurses were not sent on beforehand to prepare the house for operation and the surgeon as a rule turned up with just his instruments and dressings to a house where everything had to be improvised. Under these circumstances a resourceful and handy man who would willingly turn his hand to anything from lighting a fire to giving an anæsthetic and assisting an operation was a distinct asset especially to busy surgeons.

Thus, gradually, he made a niche for himself, and incidentally for his successors, and Anæsthetics became recognised as a specialty. But it was uphill work, and for some years private cases were few and far between, but after three years men from outside hospitals began to give him work and a steadily increasing anæsthetic practice came into being. He began anæsthetic practice

with a distinct prejudice in favour of chloroform, and at first employed it alone, but gradually came to use the A.C.E mixture or ether given on lint when a more stimulating agent seemed to be required. Eventually he became an ardent convert to ether but his attention was first directed into this channel through a special request that he should give nitrous oxide and ether to a certain patient. He had not seen that combination administered, Clover's apparatus was not available and Hewitt's was not then on the market. In 1887, however, he had been appointed anæsthetist to the Victoria Dental Hospital, Manchester, and so was familiar with the administration of nitrous oxide there. With an old disused "Clover," a two-way stopcock and gas bag and a fishing rod ferrule he extemporised an apparatus with such satisfactory results that from that moment he became a convert to ether, though it was some time before he became expert in its handling and longer still before the surgeons became reconciled to it. An uninstructed beginner and learner is not the best exponent of a new method and this no doubt affords some excuse for the attitude of the surgeons. Ultimately, with improved technique, prejudices were overcome and ether, to a large extent, superseded chloroform, at least at the Infirmary, and also began to come into favour elsewhere. This was especially the case after the introduction of a preliminary injection of Atropine and the institution of the "open ether" method. In spite of his perseverance with ether it was at times almost impossible to resist the unexpressed, or on occasion, the forcibly expressed desire of the surgeons to revert to the old familiar chloroform, but with increasing efficiency in administration ether became more and more tolerated if not actually appreciated by many surgeons. This progress towards the recognition of ether was helped considerably by the appointment of Mr. A. G. Andrews as second anæsthetist. The latter had been trained at the London Hospital and used ether as a routine anæsthetic. Still it cannot be said that the virtues of ether were generally recognised and appreciated until the introduction of the "Open Ether" method, preceded by a preliminary hypodermic injection of atropine. The real credit of introducing it into the Manchester Royal Infirmary belongs to Dr.A. Donald who employed it in all his gynæcological operations and became, and still is, a warm advocate of the method. Those who had tried to demonstrate the virtues of ether in spite of much opposition, had to listen to a recital of its advantages as some-

thing new. The "Open Method" rapidly caught on, especially when apart from its simplicity and safety it became recognised, largely through the persistence of Mr. A. H. Burgess, that it was free from the severe post-operative toxic effects of chloroform in acute infective conditions of the abdomen. A marked reduction in post-operative mortality ensued, especially in cases of acute appendicitis.

In the late nineties, the renewed interest in the dosimetric method of giving chloroform awakened by Dr. Dudley Buxton, Professor Waller and others led to its prompt introduction to the Infirmary, first by means of Vernon Harcourt's inhaler and later by the Roth-Drager Chloroform, Ether, and Oxygen apparatus. The latter, employed chiefly in operations on the brain, spinal cord and thyroid, constituted a great improvement on previous methods, both as regards efficiency of administration and as an aid to asepsis by removing the anæsthetist from the immediate sphere of operation. Under Mr. Wilson's guidance practically all new methods of anæsthesia which offered any promise of usefulness were early tried out. Amongst these may be mentioned intra-venous ether, and intra-tracheal anæsthesia. The former method was discarded almost at once but the latter was retained and regularly used in selected cases. For the intra-tracheal method Mr. Wilson improvised a somewhat bulky but highly efficient apparatus which he later replaced by a more perfect and better finished machine.

Correct surgical postures on the operating table were always a matter of considerable interest to him, and his intimate association with the late Sir Wm. Thorburn in operations on the spinal cord led him to devise a special posture for the operation of laminectomy. The patient was turned completely on his face, the chest, pelvis and thighs being supported on sand pillows, leaving abdominal respiration unembarrassed and the spine exposed in its whole length. The method is described in detail and fully illustrated in Sir Wm. Thorburn's articles on this subject. The special use of a rocking chair for Mr. Whitehead's operation for intra-buccal removal of the tongue was devised by him and fully described and illustrated in Whitehead's article.

It fell to his lot to lay the foundations of anæsthetic teaching in Manchester and feeling that mere theory was of little use in so practical a branch of medicine it was his custom to take two or three students at each operation and explain to them the methods and

principles involved. Later, in order to avoid continual repetition this individual tuition was preceded by a short course of lectures, so that the student commenced his practical course with some knowledge of his subject. The method employed was not to simply hand out anæsthetic information to the student but to get him to apply his existing knowledge.

Always most careful and painstaking, Mr. Wilson was never greatly inclined to rush into print but after several years he published several contributions of an essentially practical nature. The chief of these were :—

"Anæsthetics for Children in Ashby and Wright's Diseases of Children."

"The Mechanism of Death under Chloroform." *The Lancet*, 1894.

"The Hyderabad Commission." 1890.

"Resuscitation in Emergencies under Anæsthesia." *Soc. Anæsth.* 1898.

"Treatment of Accidents under Chloroform." *Med. Chron.*, 1901.

"Anæsthetics in Tonsillectomy." *Med. Chron.* 1910.

(With Walter Whitehead) "Excision of the tongue for Cancer." *Practitioner*, 1903.

Various communications to the Odontological Society..

Foremost amongst his publications were those which dealt with the highly contentious question of the cause of death from chloroform. The first to appear was a criticism of the findings of the Hyderabad Chloroform Commission from a clinical standpoint in which he endeavoured to show that symptoms in fatal chloroform accidents indicated that death was not due to respiratory failure but to primary failure of the circulation. Following up this conception he conceived the idea of comparing the symptoms of death under chloroform with those of death from failure of the circulation from other causes—hæmorrhage etc. Hitherto, the subject had been investigated almost entirely from the experimental point of view with extremely contradictory results. He pointed out that the symptoms of sudden death under chloroform were practically the same as those of sudden death from rupture of an aortic aneurism or of sudden heart failure in acute peritonitis. In later

papers he followed up the idea and amplified it with illustrative cases from Snow's Anæsthetics and other sources and offered a satisfactory explanation of those perplexing cases in which after a few inhalations of chloroform the patient goes into convulsions and dies. These principles were thoroughly instilled into those who studied under him and at a time when observation of the respirations was considered all sufficient he emphasized the fact that the pulse was the first to go in these dramatic collapses. Failure to recognise this was a grave danger, for the breathing was increased (air hunger) and the patient's limbs often showed movement, deluding the inexpert administrator into the belief that the anæsthetic was too light. This often led to the application of more chloroform and a postponement of remedial measures to a time when they were likely to prove unavailing. The exaggerated breathing was due to anæmia of the Respiratory Centre and the movements were anoxæmic convulsions indicative of immediate dissolution. He also emphasized the importance of partial or complete inversion in the treatment of this form of collapse. Looking back on his work in the light of modern scientific knowledge we may congratulate him for practically all his careful clinical observations have been amply confirmed by experimental work and his special points are easily demonstrable in animals in whom this form of collapse can be artificially produced.

Whilst Alexander Wilson did great service to Anæsthesia in the Provinces in virtue of his careful observations and by his conspicuous abilities as a practical administrator, he possibly did an even greater one in securing its recognition as a greatly respected branch of Medical Specialism. This was effected by his own personality and high ideals for his art. After twenty years of diligent service, the Board of the Manchester Royal Infirmary honoured him by electing him a member of the Honorary Staff of the Institution in 1906. Until then, Anæsthesia had been rather looked upon as an entirely minor branch of Surgery and the anæsthetist as a necessary evil. The Manchester Medical Society appointed him a Vice-President and he held the post of a Vice-President of the Anæsthetic Section of the B.M.A. at the London meeting in 1908.

It is also a matter of interest that he was one of the original members of the Society of Anæsthetists (1893) now represented by the Anæsthetic Section of the Royal Society of Medicine.

On the outbreak of war he was attached to the 2nd Western General Hospital as Anæsthetist, but shortly after was raised to the rank of Major and worked through the whole period of the War as a member of the Administrative Staff. Whilst no longer engaged in active anæsthetic practice, he still retains a keen interest in anæsthetic progress and is always willing to help and advise those who are carrying on the work he so worthily initiated. He will always remain in our memory as Manchester's first Anæsthetist and the earliest Pioneer of Anæsthesia in the Provinces.

CHOICE OF THE ANÆSTHETIC.

By W. Webster, M. D., Winnepeg.

IN selecting the anæsthetic for the individual patient and operation, one is influenced by many considerations: age, sex, muscular developement, condition of the heart, lungs, liver, kidneys, etc., also the site of the operation, whether on the brain, abdomen, etc. The anæsthetist of today has at his disposal a number of anæsthetics from which he may select the one most suitable for a given case or operation. He has also a variety of methods of administration and we must look upon the practice of using one anæsthetic in a routine way as belonging to a bygone time. To obtain the greatest success we must vary our anæsthetic and method of administration to suit the case in hand. There are not wanting, however, some who use a single anæsthetic for all purposes claiming, in the case of nitrous oxide-oxygen for example, that they obtain the best possible results by this method. Doubtless by this narrowing down and concentrating on one anæsthetic they become singularly adept in its administration. The best ultimate results however—and the object for which we are all striving—so far appears to come from an intelligent selection and skillful use of the several tried and well known anæsthetics.

It is a popular fallacy to believe that those in good health, with good muscular developement, are the best risks for anæsthesia. This is not invariably the case. Of course as against those with organic disease of the heart, lungs, etc., they are much safer risks; but these being absent one usually finds the weaker, asthenic subjects, who have lain in bed for some time, prove much easier and safer cases for anæsthesia.

A greater depth of anæsthesia is usually required for the former than the latter type, and a far larger quantity of the

anæsthetic must be inhaled to produce the requisite degree of relaxation and to prevent any inconvenient reflex movements. The latter type may remain passive to surgical procedures even when the lid and corneal reflexes are fairly active. At the same time they will not hold out against a given strain as long as a stronger person.

When untoward symptoms appear during the course of the anæsthesia, the cause of these, and their remedy, is the important question with the anæsthetist and the one with which he must be able and ready to cope immediately. The quickness with which any slight variation from the normal is noted is one mark which distinguishes the skilled anæsthetist from the mere tyro.

The degree of confidence which the patient reposes in the anæsthetist, which varies much with the personality of the latter, is of the utmost importance. It tends, along with skill in administration, to prevent the period of excitement and consequent struggling which is happily much less seen now than in the past, when a less degree of skill on the part of the anæsthetist was not only tolerated, but expected; and when it was generally considered a necessary part of the procedure to hold the patient down during the second stage of anæsthesia. Any struggling, especially of a violent nature, represents a serious loss of the patient's energy. An excessive strain is thrown on one, possibly already weakened by some intercurrent disease, or who may be suffering from an impaired cardio-vascular system. There is danger of losing sight of the fact that over-exertion, or severe effort, sustained over even a short period of time by the conscious or semi-conscious subject, is sometimes followed by acute cardiac distress or syncope. Violent struggling may therefore be the cause of sudden death following operation, or of gradual cardiac failure during the postoperative period. At the best it usually leads to a poorer type of anæsthesia throughout the operation, owing to some subconscious remembrance of the period of excitement. This waste of energy added to the strain of operation, may easily turn the scale against the patient and change what might have been a successful result into a disaster.

GOITER-THYROIDECTOMY.

The condition here varies greatly, all the way from a simple adenomatous enlargement to a severe toxic condition, with exophthalmos, heart and nervous systems. The patient may suffer from severe pressure on the trachea. The trachea is narrowed from before backward, or laterally according to the pressure. If the pressure is principally on one side, one usually gets also a displacement of the trachea, which is pushed over somewhat to the opposite side. Owing to this pressure the wall of the trachea may be thinned considerably, the rings occasionally having almost disappeared from atrophy, caused by the pressure. This condition brings us face to face with two possibilities of trouble: the trachea collapse on removal of the gland and so cause closure, partial or complete of the airway; or in the surgeon's effort to separate the gland the trachea may be torn open. Either is an exceedingly undesirable complication. Our choice of anæsthetic is, therefore, controlled by various factors. Many advocate following Crile who uses nitrous oxide-oxygen together with local anæsthesia; an admirable combination in many respects. However after considerable trial of this combination of nitrous oxide-oxygen with local and without, the author has found that with nearly all subjects the quantity of nitrous oxide is not lessened by the addition of the local anæsthetic. It is seldom necessary in either case to abolish the lid and corneal reflex. The theory that the local anæsthetic is required to cut out the transmission of impulses of the brain does not seem to be proved, for it has recently been shown, by extremely delicate galvanometric experiments, that impulses from a site of operation are only transmitted along a nerve to the first synapse when the subject is in a condition of surgical anæsthesia. The lighter stages of anæsthesia were not so effective in this respect. It has been shown also by numerous workers that similar changes in the cortical cells occur from anæsthesia alone without the stimulation of operation, also from fear, excitement, etc. Against its use is the loss of time engendered while injecting the parts and the slight œdema of tissues which make for further loss of time with those unaccustomed to work with injected tissues.

The ether-oil colonic method may be used and has the merit of keeping the anæsthetist completely removed from the surgical field.

Intratracheal insufflation, either by ether or chloroform, has been also frequently used and has the same advantage of allowing the anæsthetist to sit some distance from the site of operation. The anæsthetic can be controlled between very narrow limits and usually kept as light as with nitrous oxide-oxygen; for the mechanical nature of the respiration itself appears to have a slight hypnotic effect. There is a possible danger, though extremely remote, that in introducing the catheter into the trachea, perforation might occur when the wall is very thin from atrophy and more so if it is also displaced, so that the catheter, instead of following a straight course, has to bend by pressure against the tracheal wall. In many cases one of the vaporising inhalers with an oxygen tank attached instead of the usual motor or bellows, so as to supply oxygen along with the ether, gives excellent results. The question of expense, or absence of the necessary machine sometimes prevents the use of nitrous oxide.

Other external and internal growths may also cause obstruction to respiration. In some cases it may even be necessary to do a preliminary tracheotomy and give the anæsthetic through the tracheotomy tube. The latter is no difficult matter, the anæsthetic tube from one of the various vaporizing machines or nitrous oxide-oxygen inhalers being inserted into the tracheotomy tube; or the Trendelenburg apparatus may be used if it is desired to give the chloroform or ether by this method.

When the respiration is wholly thoracic, or wholly abdominal, as is sometimes the case, the former when the abdomen is greatly distended or the muscles held rigid as in severe ascitics, intestinal obstruction, peritonitis, ovarian disease, etc; the latter in advanced emphysema or other disease of the lungs or pleura. Thoracic or abdominal respiration is often exaggerated in these cases as a matter of compensation and particular care must be exercised over the respiration and circulation. After the cause of distention has been removed the breathing becomes easier and the circulation usually improves.

In upper abdominal surgery, especially in extensive operations on the bile passages, observations have shown that a reduction of 30—40% in the output of the lungs occurs, clearly demonstrating the serious embarrassment to breathing which this surgical procedure produces. Further, deep anæsthesia is required, which renders the respiratory centre less sensitive. The traction exerted by the surgeon and his assistants still further complicates matters. The breathing is almost wholly abdominal. If using nitrous oxide it is usually necessary to supplement this with a certain amount of ether unless one is willing to carry the nitrous oxide anæsthesia to the point of "secondary saturation". Ethylene gives greater relaxation than nitrous oxide but not so great as ether. With acetylene our experience has not yet been large but it is spoken of very favourably by Weiland, Gauss, and others. In using either ethylene or acetylene one finds it advisable to commence the introduction with nitrous oxide on account of the disagreeable odour at present given off by these gases, though we are assured by chemists that when absolutely pure these gases have no unpleasant odour.

Where drainage of the abdominal cavity or of an empyema is necessary, it may often be done under local anæsthesia. There are, however, many of these cases in which a general anæsthetic is preferable, either from nervousness on the part of the patient or other reasons. Nitrous oxide-oxygen or ethyl chloride will generally be found best in these cases The patient is usually very weak, especially in empyema; the dose of anæsthetic required is not large and either of these anæsthetics is rapidly eliminated causing little or no after distress to the patient. Nitrous oxide-oxygen has the advantage of being capable of administration under a slight positive pressure, which permits the distention of the lungs, in recent cases after the fluid is evacuated, should this be considered advisable.

In chronic pulmonary disease, chronic bronchitis, emphysema, chronic phthisis and old pleural disease, anæsthetics are taken much better than in the more recent cases, The respiratory mechanism has, by constant use, become adapted to circumstances, instead of, as in recent cases, being in process of establishment. Closed methods, speaking

generally, should be avoided, plenty of air or oxygen being allowed. Nitrous oxide-oxygen alone or with the addition of a little ether or C. E. may be used. It is more important to keep the patient well oxygenated and prevent violent respiratory efforts than to avoid the use of some other anæsthetic in combination with nitrous oxide-oxygen. If nitrous oxide-oxygen is not available, chloroform or C. E. mixture, in skilled hands, are perhaps better than ether, being less irritating to the air passages.

The Circulatory System.

It is often erroneously supposed that the possessors of a vigorous vascular system are good subjects for anæsthesia and that the person with a weak circulation, with organic or functional circulatory derangement is unfit to take the anæsthetic. Almost the opposite is the case, the former usually having a powerful vigorous physique, may be the cause of considerable anxiety to the anæsthetist by struggling, or muscular contraction causing impediment to free respiration. The latter usually possess comparatively feeble muscular developement and pass into anæsthesia with no excitement.

In valvular and other cardiac affections extreme care must be taken not to embarrass the circulation by any restriction of air, therefore, if nitrous oxide-oxygen is used there must always be a sufficient supply of oxygen to maintain a well oxygenated condition of the blood. If necessary add ether rather than reduce the supply of oxygen below the need of the case. C. E. followed by ether, may be used on an open mask, but both are better given with oxygen through one of the vaporising inhalers.

In patients, the subjects of atheromatous arteries, there must be avoidance of struggling, holding of breath or any restriction of air during induction. Instances of cerebral hæmorrhage are on record during induction with struggling and holding of breath even in chloroform anæsthesia. It has occurred during anæsthesia when there was very little struggling. A preliminary dose of morphine or atropine is often advisable in these cases as it assists quiet induction.

In subjects of aneurism the same avoidance of struggling coughing, straining, etc., must be secured.

In venous thrombosis cases have been cited, both under ether and chloroform, in which the clot has been dislodged during induction or later in the anæsthesia. It is quite probable that some of the sudden deaths recorded under anæsthetics and ascribed to their action, have been due to cardiac or pulmonary embolism.

Exhaustion, collapse, or shock may be found in patients who are the subjects of long standing illness, or some severe prostrating disease, e.g. suppurating hip disease, especially in children; advanced stricture of the pylorus, strangulated hernia, intestinal obstruction, injuries caused by machinery, etc. In these, nitrous oxide-oxygen is usually the anæsthetic to be preferred. In these patients during the anæsthesia the eyelids remain separated, the globes turned upwards so that the sclerotics only are visable and profuse sweating—another indication of exhaustion—is common. The rosy cheeks of hectic subjects and those artificially stimulated with drugs must not be allowed to deceive the anæsthetist, as these signs may coexist with a circulation totally unable to withstand a prolonged operation, though a shorter operation may be fairly well borne. Often the pulse improves somewhat under ether, but later becomes weaker and is often apt to show greater weakness when the ether is withdrawn than during its administration. This early improvement of the circulation may be due to a slight stimulation of the nervous patient's anxiety as to his condition.

In intracranial surgery ether or nitrous oxide may be used. The former is most conveniently given, by one of the vaporizing inhalers, either mixed with air or oxygen. Chloroform is preferred by some. Mixed with oxygen there is less bleeding than with ether or nitrous oxide—the brain being rendered more anæmic—probably due to the lower blood pressure of chloroform anæsthesia and when given with oxygen to the better oxygenated condition of the blood which can carry the required oxygen to the cells with less effort on the part of the heart. This is a matter of considerable convenience to the surgeon in operating: but the more pronounced breathing and fuller pulse of ether anæsthesia is a source of great comfort to the anæsthetist, being one of the chief indications left to him of the condition of the patient,

when the face is covered by towels etc. Owing to the lessened flow of blood through the brain when the intracranial pressure is increased, a higher percentage of anæsthetic in the blood is required to secure anæsthesia than when intracranial tension is normal. When the pressure is relieved by opening a dura, a considerable increase at once takes place in the volume of blood flowing through the brain so that a dangerous, or even lethal dose of the anæsthetic, suddenly bathes the medullary centres. This must be anticipated by the anæsthetist and the dose of the anæsthetic lessened or even, if considered necessary, altogether withdrawn at the time of opening this membrane.

In brain surgery, once the site of operation has been draped with towels,etc., the face is hidden. The upper part of the body is left completely to the surgeon and his assistants, the anæsthetist usually sitting about opposite the patient's knees. He must be content with what information he can gather from the patient's respiration and circulation as determined by the radial pulse of the side on which he sits, and can note the peripheral circulation as shown in the skin of the hand or finger nails. If taking the blood pressure also he has a still better guide to the conditions of the patient.

The method of anæthesia may be similar to that used for a mouth operation, Doyen's gag with anæsthetic tubes is usually retained better than an anæsthetic tube without a gag. Some prefer nasal tubes and the intra-pharygeal methods, others the intratracheal method. By any one of these methods ether may be administered mixed with either air or oxygen. Oxygen in these cases is to be preferred mixed with ether; for in the event of any interference with free respiration, caused by the position of the head, the decrease of the volume of air breathed is compensated by its richness in oxygen. Of course if the intratracheal method is adopted, the airway is kept free by the intratracheal tube this being the principal reason for the use of the method in brain surgery.

Nitrous oxide-oxygen or nitrous oxide-oxygen with ether, is sometimes preferred and may occasionally be strongly indicated. Here the necessity for closely fitting the face mask and the large diameter and less flexible tubing used with the

nitrous oxide apparatus makes the administration more difficult with the patient in the lying position. Care must be taken also to provide sufficient oxygen with the mixture at all times, or venous engorgement may result and materially increase the difficulties of the surgeon.

In depressed fracture, intracranial hæmorrhage, cerebral abscess or tumour, the patient may be semi-conscious, when very little anæsthetic is necessary; or if in a state of coma no anæsthetic is required.

During menstruation it is better to avoid an anæsthetic unless the operation is urgent. In some patients the nervous system is more unstable during this period; further, hysterical patients may ascribe a multitude of after-effects to the fact of an anæsthetic being given, or an operation performed at this time.

During pregnancy anæsthetics may be given. Care should be taken that there is no restriction of air which might cause muscular spasm, especially in the later months. During *lactation*, anæsthetics may be given without interfering with the process.

In those afflicted with *insanity* the disease may be exaggerated temporarily, though this seems to be a rare occurence.

In *epileptics*, seizures have been reported during anæsthesia. It must be of rare occurence and one would imagine must be confined to the introduction period. In both these types particular care should be exercised to obtain a quiet induction if possible.

Occasionally in the past it has been necessary to use the *actual cautery* in the mouth and nose or parts adjacent to these orifices. With the advent of diathermy, now so frequently used in malignant growths of the face and its orifices, the occasions have multiplied greatly. Of the anæsthetics in use to-day all are inflammable and with a certain percentage of air or oxygen more or less violently explosive, except nitrous oxide and chloroform. In work on the upper part of the body we are therefore restricted to these two anæsthetics. Nitrous oxide may be conveniently used when the site of operation is sufficiently removed from the nose and mouth to allow the use of the ordinary facemask. Unfortunately most of our cases of diathermy are within

the mouth. Gas may be given by the nasal inhaler or by a tube in the mouth as for tonsils and dental surgery. A large quantity of gas is required to maintain anæsthesia by this method owing to the need of using pressure above that of the atmosphere so that if the operation is of long duration the question of expense arises and one must have recourse to the cheaper anæsthetic- chloroform. It is not always a question of expense, however, many surgeons preferring the latter drug which is given by one of the vaporising inhalers intended for this drug. Stocks or the ancient Junker or one of the later patterns of ether-suction machines, e. g. the McKesson, care being taken to remember that the percentages shown on the scale are for ether and that, while high percentages of that anæsthetic are required, when using chloroform only about one-sixth of the quantity is needed to produce the same effect. The latter drug being of higher specific gravity does not vaporise so readily and will therefore be presented in a less percentage than the indicator shows, so that the indicator on the McKesson machine will often be at the three per cent. mark—as shown for ether—though frequently the one or one and a half per cent. will give a sufficient strength.

THE INFLUENCE OF DIATHERMY IN ANÆSTHESIA ON BODY TEMPERATURE, BLOOD CONCENTRATION, AND ACIDOSIS.

By Wesley Bourne.

THE problems of air movements, of temperatures and of humidities have been investigated vigorously in attempts to improve conditions for those who work in mines; in attempts to provide an environment as ideal as possible for the preservation of the valuables of art galleries and museums; and in attempts to obtain optimal states for the better manufacture of all sorts of materials of merchandise. The excellent results obtained in these respects are recognised by but a few. To these same problems as applied to hospitals, as yet, very little attention has been paid. It is true, that some observations have now and then been made; Moschcowitz[1] reported several fatalities from postoperative heat stroke with greatly increased body temperatures, and pointed out that although heat stroke occurs without the coincidence of surgical procedures, nevertheless these seem occasionally to determine the appearance of insolation. He suggests that, with the exception of urgent cases, all operating room activities should cease during periods of high temperatures which are associated with great humidities and the absence of air currents. Recently Botteselle[2] has reported several cases with very similar results. Walton[3] found a greatly increased death rate in cases of hyperthyroidism after operation during the summer months.

Huntingdon[4] has made very concrete recommendations concerning the purpose and methods of air control in hospitals and has shown that "proper conditions of temperature, humidity, movement and variability of air are vitally necessary."

Certain laboratory experiments are important in this connection: Barbour and Lozinsky[5] find that the normal dog is unable to accommodate itself to saturated atmospheres at environmental temperatures higher than 28°C (82.4°F.), and that the regulation of this same animal does not break in dry atmospheres until the room temperature reaches 38°C (~~90.4°F.~~ 100.4°F.). With the

anæsthetized animals the results are different: Barbour and I[6] have presented data which show:—firstly, that whereas the body temperature is ordinarily lowered during narcosis, it may be maintained at its normal level in dogs when the temperature of the environment is about 31°C. (87.8°F.) in either wet or dry atmospheres; secondly, that irrespective of environmental conditions, ether causes a concentration of the blood, which is chiefly due to the passage of water from the blood to the tissues, corroborative evidence of which has been supplied by R. L. Stehle[7] and myself, inasmuch as it was found that after ether anæsthesia the water content of the muscles was increased; and thirdly, that this blood concentration may be completely offset by the preanæsthetic administration of water or hypotonic solutions, but in this case, in spite of the previously determined optimum of environmental conditions the body temperature falls. In another set of experiments[7] I have demonstrated that when the room temperature is elevated to 33°C. (91°4F.) anæsthetized animals, which have previously had water or hypotonic solutions, maintain their body temperature, and the fluidity of their blood is not changed. It is also found that whereas the temperature of morphinized dogs falls very slightly within a period of one hour of the administration of the drug, the superposition of ether anæsthesia causes the usually marked fall in body temperature while that of the surroundings is ordinary. And now, curiously enough, the customary increase in blood solids is almost completely offset. Although Holme[8] reports concentration of the blood after morphine, his doses were from 28 to 40 mg. per kilo and his measurements were carried out twenty to thirty minutes after administration. In our experiments the dose was 10 mg. per kilo and the observations were not made until after one hour.

As it is impossible for man to work in such temperatures as approach these without considerable discomfort, it is quite out of the question for us to have our operating rooms much warmer than they ordinarily are, and as all other methods of maintaining body temperature are rather impracticable and difficult of control, it was decided to try the effect of diathermy. The experiments were conducted on fasting dogs. A high frequency current* was passed

* I am indebted to Dr. Colin E. Ross of the Western Hospital, Montreal, for the use of his machine, and to Mr. L. R. McDonald for his advice in operating it.

through the animals by placing one pole at one end of the body and the other at its opposite end. The results are set forth in the table. Experiment 1 shows that the initial depression of body temperature after ether, was followed by a rise to one above the normal when from 800 to 1,000 milliamperes were used. It next became desirable to know what effect, if any, such a procedure would have on the blood concentration. Experiment 2, 3, 4, 5, and 6 show this; as is evident, marked variations occur, and it is believed that diathermy has no effect in this regard. The fluid state of the blood in anæsthesia seems to depend entirely on the amount of water available in the body generally. In experiments 3, 4 and 6 the current was applied before etherization and it may be seen that body temperature rises readily above the normal.

Experiment		1	2	3	4	5	6
Weight of dog		8 Kg.	15 Kg.	18 Kg.	24 Kg.	7.2 Kg.	10.5 Kg.
Rectal temperatures degrees Fahrenheit.	Before ether or diathermy	101.8	105.4	103.6	101.8	101.8	102.4
	Before ether & 20 mins. after diathermy.	—	—	104.0	103.0	—	102.7
	Immediately after ether.	100.6	104.2	103.2	102.6	100.4	102.6
	During diathermy and anæsthesia.	100.6 to 101.9	103.0 to 103.6	103.4 to 103.7	102.6 to 102.7	101.0 to 103.0 to 102.4	102.4 to 102.6
Milliamperes		800-1000	1000-1100	*1000-1200	1000-1075	1000-600-0	1100-1250-1000
Anæs. in minutes.		70	50	65	130	60	45
Blood solids per cent.	before	—	16.5	19.5	23.3	21.0	18.7
	after	—	18.0	19.8	25.3	22.0	20.4
CO_2 capacity of plasma c.c. in 100.	before	—	—	--	54.8	44.3	—
	after	—	—	—	37.6	31.9	—
Phosphorus in urine. mg. per hour.	before	—	—	—	23.30	0.90	—
	during	—	—	—	0.87	11.66	—
	after	—	—	—	31.60	0.96	—
			Animal evidently ill. Died 36 hours later.	*Fluctuating throughout.	Urine in 24 hour periods.	Bladder fistula dog. 250 c.c. H_2O by mouth 3 hours before.	No water for 24 hours.

All dogs fasted 24 hours before.

Another matter of interest was to determine the influence of the maintenence of temperature on the acidosis of anæsthesia, accordingly the carbon dioxide combining power of the plasma was measured by the method of Van Slyke and the phosphorus output in the urine by Pregl's micro-procedure[9]. Experiments 4 and 5 gave the results and it was found that the alkali reserve of the blood is lowered and the phosphorus excretion is increased, in other words the ordinary acidosis of anæsthesia is not interfered with by changes in body temperature. It is worthy of note that in the dog of experiment 4 there was almost complete anuria during the anæsthesia period with a consequent and concomitant depression of the phosphorus excretion, which later was markedly increased in the postanæsthetic remainder of the twenty-four hours. Whereas with the female animal of experiment 5, on which a bladder fistula had been previously performed so that urine could be collected as it was secreted, in this instance, on account of the light narcosis and probably too because of the preliminary administration of water there was no anuria and the phosphorus was excreted rapidly during anæsthesia, so much so that during the first twenty minutes there was as much as twenty times more per minute than in the control period. It should be mentioned that all of these animals were fasted for twenty-four hours but allowed to take water as they desired with the exception that the dog of experiment 5 had been given 250 c.c. of water by stomach tube three hours before anæsthesia was begun, and the one of experiment 6 received no water for twenty-four hours.

The room temperature was about 65°F. in all cases because it was necessary to open a window to avoid ether explosions from the sparking of the high frequency machine. In this connection Mr. L. R. McDonald is at present building an apparatus of very high efficiency for the same intense heat, with a lower voltage and continuous wave in order that all spark gaps may be eliminated. When this is perfected it is hoped that the method may become benificially applicable in the operating room.

Summary.

A fall in the body temperature caused by ether is followed by a rise to, or about normal after application of diathermy.

The preliminary use of diathermy will prevent the drop in temperature which ordinarily occurs in anæsthesia.

Diathermy does not influence blood concentration.

The acidosis of anæsthesia is not changed by hindering the fall of blood temperature.

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CARBON DIOXIDE in GAS and OXYGEN ANÆSTHESIA,*

By J. Ross Mackenzie, M.D.,

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GAS and Oxygen, at atmospheric pressure, is an inefficient anæsthesia for major surgery. The amount of any gas in the blood depends upon its pressure in the pulmonary alveoli. The difficulty which confronts us in actual practice is to get into the blood a percentage of nitrous oxide Ethylene or Prophylene, sufficient to anæsthetise the patient without producing some degree of asphyxia from deficiency of oxygen. It has been shown that a method of achieving this object is to deliver the gases to the patient under greater pressure than atmospheric, and several methods of automatic pressure upon the distended gas-bag have been used with indifferent results.

In practice the supply of gases to the patient is measured by the number of holes from which the gases flow in the sight feed bottle, and the pressure of the gases in M.M.Hg. may be approximately calculated in the same way.

Pressure of Gases in M.M.Hg.

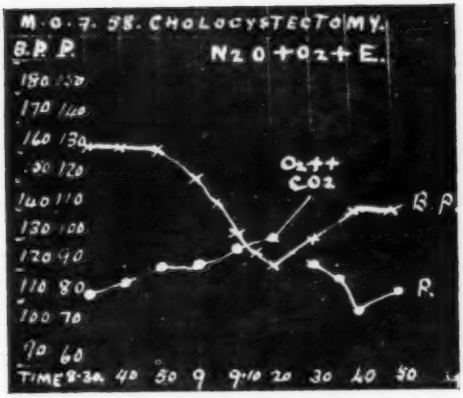
Nitrous oxide alone at atmospheric pressure (760 M.M.Hg.) gives complete surgical anæsthesia with asphyxia.

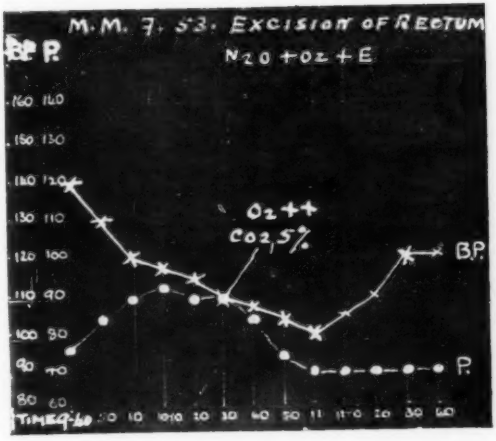
With two or more gases the pressure of each is equal to its percentage in the mixture, e.g.,

N_2O=4 holes=608 M.M.HG. O_2=1 hole=152 M.M.Hg.

This gives light anæsthesia but no muscular relaxation. The partial pressure of nitrous oxide is not enough for surgical anæsthesia, unless we reduce the partial pressure of oxygen below that in the atmosphere.

* Lecture and demonstration at the Children's Hospital, Glasgow, on the occasion of the visit of anaesthetists from the United States and Canada, July 6, 1926.


M.O.7.38. CHOLOCYSTECTOMY.
B.P. P.
N2O+O2+E.
180 160
170 140
160 130
150 120
140 110
130 100
120 90
110 80
100 70
90 60
O2++
CO2
B.P.
P.
TIME 8·30 40 50 9 9·10 20 30 40 50


M.M. 7.53. EXCISION OF RECTUM
B.P. P.
N2O+O2+E
160 140
150 130
140 120
130 110
120 100
110 90
100 80
90 70
80 60
O2++
CO2 5%
B.P.
P.
TIME 9·40 50 10 10·10 20 30 40 50 11 11·10 20 30 40

If the pressure be increased to $1\frac{1}{4}$ atmospheres, (950 M.M.Hg.)

$N_2O = 4 = 760$ M.M.Hg.	$O_2 = 1 = 190$ .M.M.Hg.
$N_2O = 5 = 790$ M.M.Hg.	$O_2 = 1 = 160$ M.M.Hg.

we have a deeper anæsthesia with muscular relaxation and no deficiency in the pressure of oxygen.

Drs. Dale[1] and Hill suggest that operating theatres should be equipped as pressure chambers. Under this condition they predict wider scope, deep surgical anæsthesia, and a brilliant future for gas and oxygen anæsthesia. At present this is not practicable and the alternative open to us is to use:

(a) Local infiltration or reginal analgesia.
(b) Re-breathing or inhalation of carbon dioxide.
(c) Pass the gases over ether.
(d) De-etherisation.

The Effects of Carbon Dioxide Deficiency.

(a) *Tissue Asphyxia.* The internal respiration of the cell is dependent upon an adequate supply of oxygen. With gas and oxygen anæsthesia there should not be at any part of the anæsthesia a deficiency of oxygen, but the mere presence clinically, of sufficient oxygen in the blood, is not evidence that the tissues may not be suffering from want of oxygen. It has been[2] shown that if the carbon dioxide in the tissues or blood is reduced below normal for any reason , then the oxyhæmoglobin retains its oxygen and the tissues suffer from anoxæmia, though the patient's colour is good.

(b) The cumulative action of nitrous oxide over a long period, if accompanied by a deficiency either of oxygen or carbon dioxide, may produce acute toxæmia. There is danger of asphyxia of the heart mucscle, as well as stimulation of the cardio-inhibatory centre in the medulla, with pallor and slow pulse. This has not been sufficiently emphasised, and may be the main cause of fatal accidents that have occurred suddenly.

(c.) *Apnœa.* Ether vapour stimulates the depth and rate of respiration for a period. Visceral manipulations also cause hyperpnœa. If the expiratory valve is kept open, carbon dioxide will be lost and the respiration ceases. Apnœa may effect the cardio-vascular and vaso-motor systems to such an extent as to be fatal

in feeble subjects, especially if the surgeon continues his visceral manipulations.

(d.) The pallor, sweating, low blood pressure, rapid pulse and collapse seen in prolonged surgical operations, are largely due to carbon dioxide and oxygen deficiency.

Re-breathing or Inhalation of Carbon Dioxide.

Re-breathing is an important factor in gas and oxygen anæsthesia, and when regulated to suit the susceptibility of the individual patient, is of immense value:

Re-breathing (a.) saves the gases,

(b.) it conserves the patient's body heat,

(c.) it retains the carbon dioxide in the expired air,

and this is of vital importance to the patient.

The value of carbon dioxide in the animal economy has been the subject of much research by physiologists on both sides of the Atlantic.

Carbon dioxide is the chemical regulator of the respiration, and the extreme sensitiveness of the respiratory centre to carbon dioxide, is shown by this fact pointed out by Dr. Haldane,[4] that a variation either plus or minus, of 0.01% in the alveolar air, will produce 5% increase or decrease in the pulmonary ventilation.

What then are the advantages in practical anæsthetics of a moderate increase (2–5%) of carbon dioxide in the alveolar air?

Operative Advantages.

1. It hastens the induction of anæsthesia.

In adults, 5% carbon dioxide doubles the pulmonary ventilation, and rapid, easy induction of anæsthesia takes place. Infants are difficult to anæsthetise with gas and oxygen, and this fact is largely explained by reference to the physiology and anatomy of their respiratory system. Relatively to adults, infants have:

a. A small tidal wave=60 c.c. adult 500 c.c.
b. The infant trachea and bronchi are relatively larger which means a greater vital capacity=1,050 c.c. adult 3,500 c.c.
c. Smaller alveolar area=150 c.c. adult 1,000 c.c.

Hence the following important factors.

Relatively in infants the respiratory exchange to total pulmonary capacity, is half that in adults. The alveolar area from which gas and oxygen may pass to the blood is much smaller than in adults, and the increased rate of respiration in infants is out-balanced by the large vital capacity, which permits voluntary cessation of respiration without discomfort. A mask with an expiratory valve, attached directly to the gas bag, with a small percentage of carbon dioxide, facilitates the induction of anæsthesia in infants.

2. It counteracts the depression of the respiratory centre which frequently follows preliminary morphia.

3. It maintains the acid-base balance of the blood.

4 It promotes ready separation of oxygen from the oxyhæmoglobin to the tissues.

5 It improves enormously the general condition of the patient and preserves his vitality.

6. Indirectly through stimulation of the respiration, carbon dioxide has a tonic action upon the cardiac muscle and the large intra-thoracic vessels. The filling of the right heart is dependent upon the movement of the blood in the great veins, and they, in turn, are largely dependent upon active respiration.

7. It hastens the convalescence and complete recovery of the patient, by elimination of any toxic anæsthetic agent from the tissues and blood, via the respiratory system.

Post Operative Advantages.

1. Paresis or loss of tone in the muscular coat of the gastro-intestinal tract is not very uncommon after abdominal operations. The abdominal distention which follows, is not only painful to the patient, but may become serious and fatal.

The best prophylactic is gas and oxygen with carbon dioxide, ether anæsthesia. It has been shown[5] experimentally, that normal peri-staltic movements can be restored to paralysed bowel, by passing a stream of carbon dioxide over the exposed intestine.

2. It protects against post-anæsthetic repiratory complications.

Examination of the movements of the diaphragm under the radiographic screen during and after ether anæsthesia, shows that the descent of the diaphragm is frequently limited to $\frac{1}{2}$ or $\frac{3}{4}$ of an inch, whereas the normal is about 2 to $2\frac{1}{2}$ inches. This is partly due to the depression of the respiratory centre, and partly to paresis

of the diaphragm muscle, and results in collapse of the alveoli at the bases of the lungs. I suspect that this is a frequent cause of post-anæsthetic respiratory complication. In gas oxygen ether anæsthesia, the oxygen prevents asphyxia and congestion of the respiratory mucous membranes. Carbon dioxide keeps the tidal wave normal or plus. De-etherisation with oxygen and carbon dioxide provides for the patient going back to bed with a diaphragm moving freely, and alveoli at pulmonary bases well inflated.

These factors are in strong contrast to what prevails during and after deep ether anæsthesia.

3. It protects against post-operative thrombosis and embolism. There are considerable grounds for suggesting that the effects of deep ether anæsthesia may take some part in the etiology of post-operative thrombosis and embolism.

The majority of these cases are patients between 50 and 65 years, an age when it may be presumed the cardio-vascular tone is in some degree impaired. They are frequently septic cases—directly or indirectly—and consequently their blood plasma has already got toxic changes. Add to this an ether anæsthesia and make an analysis. We find, (1). A definite toxic agent in the blood producing hæmolysis, with fibrin deposit in the plasma and[6] a tendency to quicker[7] coagulation. (2). The medullary centres, respiratory, cardiac and vaso-motor are depressed and we get shallow respiration, diminished cardiac contraction, and loss of tone in the vessels. (3). General slowing of the blood stream with stasis in the capillaries and poor venous return to the right[8] heart. These are the factors which lend themselves to the formation of thrombus and subsequent embolism..

Prophylactic measures are re-breathing, carbon dioxide and de-etherisation, which promote—

1. full respiratory movements,
2. active venous return to the right heart,
3. full cardiac output,
4. normal tone of vessels,
5. no blood stasis,
6. elimination of toxic agent.

4. The post-operative collapse which has long been recognised as surgical shock due to surgical trauma, is frequently due to the

effects of a toxic anæsthetic agent, oxygen starvation, and loss of carbon dioxide. The diminished blood alkaline reserve and the exhaustion of the cortical cells in the grey matter of the brain and medullary centres found in this condition, have been shown[9] by Haldane and Mott to be due to lack of oxygen or carbon dioxide.

The pulse rate, blood pressure, general vitality, as well as the integrity of the medullary centres, can be restored by inhalation of oxygen with 5% carbon dioxide.

Charts to show the effect of oxygen with 5% carbon dioxide in restoring the pulse and blood pressure after 50 minutes of anæsthesia and surgical trauma. The blood pressure curve is indicated by x, and the pulse by a dot.

De-etherisation.

If ether has been used, it should be eliminated from the blood and tissues before or after leaving the theatre. This may be carried out by means of the patient's own carbon dioxide or by the method introduced by Professor Yandell Henderson[10] of giving carbon dioxide with oxygen.

Auto-de-etherisation.

As soon as the peritoneum is closed, or the surgeon within a few minutes of being finished in extra-abdominal operations, one closes down nitrous oxide and increases the oxygen. The patient re-breathes into the bag where accumulates oxygen, carbon dioxide and ether. As soon as the bag is distended, the expiratory valve is opened and ether, oxygen and carbon dioxide passes to the atmosphere. This process is repeated until the surgeon is finished and for a few minutes longer. Not only does the accumulated carbon dioxide stimulate respiration, but the elimination of ether helps in the same direction. The result is that the reflexes are practically all active before the patient leaves the theatre, and frequently after 60 to 90 minutes anæsthesia, he can appreciate questions by the surgeon. Where carbon dioxide is not available, auto-de-etherisation serves the purpose well.

Recently I had made for me by Messrs. Coxeter & Son, London, a triple bottle apparatus with triple sight feed, so that nitrous oxide, ethylene, propylene or acetylene, carbon dioxide and oxygen may be used at will or any combination of them. Its greatest asset is its simplicity. The carbon dioxide tube is in the centre with

holes half the size of those in the oxygen tube on the outer side, and the nitrous oxide tube on the inner side.

Five per cent. carbon dioxide will rapidly double the pulmonary ventilation without the slightest inconvenience to the patient. I have used carbon dioxide with this machine:—

1. To stimulate respiration for induction;
2. To maintain cardio-vascular tone and general vitality during a long operation;
3. To restore blood pressure and pulse rate after a severe surgical test;
4. For rapid de-etherisation.

With carbon dioxide, even after prolonged anæsthesia, 2—4 ounces of ether can be eliminated in from 10 to 15 minutes, when the patient will show active reflexes and be conscious of his surroundings.

The rapid return to consciousness is something of a triumph for carbon dioxide, and makes the recovery stage of anæsthesia dramatic in brevity, while the convalescence of the patient is assured so far as anæsthetics can assure it at present.

Elderly patients do not react so well to auto-de-etherisation as the young and middle aged. I have noted elderly people with poor pulse after auto-de-etherisation. This would seem to be due to the fact that their circulatory apparatus does not accommodate itself to the sudden abstraction of the stimulating ether together with the loss of carbon dioxide entailed in auto-de-etherisation.

The Dangers of Carbon Dioxide.

1. *Convulsions.* I have seen two cases, both in children, during de-etherisation with carbon dioxide. It appears as bilateral clonic contraction of muscles of the face, trunk, and limbs. The condition is epileptiform in character. The twitchings gradually disappeared on closing the carbon dioxide valve and increasing the oxygen.

2. Asphyxia from deficiency of oxygen where carbon dioxide is being given. This may appear as a dusky or pale hue on the patient and if continued, may produce the insidious tissue asphyxia with depression of the vital medullary centres, which is extremely dangerous to the patient.

3. Rupture of an alveolus from excessive tension in the pulmonary system. This is not directly due to carbon dioxide, but to re-breathing with positive pressure in the gas bag. It must be very rare. So far I have not found any cases in the literature of gas and oxygen anæsthesia.

Recently a boy of nine years was operated upon at the Children's Hospital for cholecystectomy and appendicectomy under gas and oxygen with ether. From the anæsthetist's point of view, there was nothing unusual in the operation, or anæsthesia. On the third day after operation, he developed surgical emphysema over the left side of the neck and chest; there was a consolidated area at the left apex. This was a case of surgical emphysema due to rupture of an alveolus. The air must have dissected its way along the wall of a bronchus to the mediastinum, and thence to the subcutaneous tissues.

4. Hypercapnia. For anæsthetic purposes, oxygen and carbon dioxide should be in separate cylinders, since with gas and oxygen anæsthesia the supply of oxygen is continuous, whereas the continuous use of carbon dioxide may become exhausting and dangerous to the patient as well as a nuisance to the surgeon.

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THOSE WHO WORKED IN THE DAWN OF ANÆSTHESIA.

CRAWFORD W. LONG.

AT the recent unveiling of the statue of Dr. Crawford Long, in the Statuary Hall, National Capitol, Washington, Dr. Hugh H. Young, Johns Hopkins Hospital, who represented the medical profession of America, delivered an address which is in part as follows, as published in the July *Hygeia*, the health magazine of the American Medical Association:*

In comparison with surgical anæsthesia, all other contributions to medical science are trivial. Before anæsthesia, surgery was a horror! Surgical operations were dreadful ordeals, a hell to the patients, a purgatory to the surgeons. The frightful shrieks from the operating rooms filled those waiting their turn in the wards with terror.

The awful experiences of operative surgery and the attendant high mortality caused the best minds in medicine to avoid operations. Indeed, for centuries many major operations in Europe were left to itinerant quacks, and in England the barber surgeons did the work while the medical profession stood by and vainly tried to assuage the anguish of the patient.

It was not until the early chemical discoveries of hydrogen, nitrogen, oxygen and nitrous oxide in the latter part of the eighteenth century that the way was found for a scientific anæsthesia. Sir Humphrey David said, in 1800, "Since nitrous oxide is capable of destroying pain it may be used in surgical operations," and twenty-five years later Hickman anæsthetized rabbits with nitrous oxide and carried out many operations on them successfully without a struggle. However, these demonstrations were unheeded, and the surgical theatre continued to be a torture chamber.

"Ether Frolics" Once Popular

But nitrous oxide and sulphuric ether, neglected by the medical profession, were seized on by the populace, who found in them

*A photo of this statue appeared in our April Number.

a pleasant means of becoming exhilarated. Itinerant lecturers on the marvels of chemistry roamed over the country and popularized their meetings by giving young people ether to breathe, while the audiences roared with laughter over their unconscious antics on the stage.

Knowledge of these drugs reached even to the distant rural hamlets. In one of these, Jefferson, in Jackson County, Ga., many miles from a railroad, Crawford W. Long was practicing his profession of medicine. Fresh from the University of Pennsylvania, he knew of the exhilarating properties of these drugs and frequently furnished ether to young men who met at his office for an "ether frolic" in the winter of 1841-1842.

But let him tell his story: "They were so much pleased with its effects that they afterwards frequently used it and induced others to do the same, and the practice soon became quite fashionable in the county and some of the contiguous counties.

"On numerous occasions I inhaled ether for its exhilarating properties, and would frequently, at some short time subsequent to its inhalation, discover bruised or painful spots on my person, which I had no recollection of causing and which I felt satisfied were received while under the influence of ether. I noticed that my friends while etherized, received falls and blows that I believed were sufficient to produce pain on a person not in a state of anæsthesia. On questioning them they uniformly assured me that they did not feel the least pain from these accidents. Observing these facts, I was led to believe that anæsthesia was produced by the inhalation of ether, and that its use would be applicable in surgical operations.

The First Patient

"The first patient to whom I administered ether in a surgical operation was James M. Venable, who then resided within two miles of Jefferson. Mr. Venable consulted me on several occasions in regard to the propriety of removing two small tumors situated on the back part of his neck but would postpone from time to time the operation from dread of pain.

"At length I mentioned to him the fact of my receiving bruises while under the influence of the vapor of ether without suffering, and as I knew him to be fond of and accustomed to inhale ether, I suggested to him the probability that the operation might be

performed without pain, and proposed operating on him while under its influence. He consented to have one tumor removed, and the operation was performed the same evening. The ether was given to Mr. Venable on a towel, and when fully under its influence I extirpated the tumor.

"It was encysted and about half an inch in diameter. The patient continued to inhale ether during the time of the operation, and, when informed that it was over, seemed incredulous until the tumor was shown him.

"He gave no evidence of suffering during the operation, and assured me, after it was over, that he did not experience the least degree of pain from its performance. This operation was performed on March 30th, 1842."

Here, then, was the first attempt to render a patient insensible to pain during a surgical operation! This was the beginning of a new era that was to revolutionize surgery and make it a million times more efficient in alleviating human ills.

Long did not rush into print, but like a painstaking, modest scientist quietly continued his work, removing another tumor on the same patient a few weeks later, and then amputating a toe under complete anæsthesia in July.

His meagre practice furnished him with only a few surgical cases each year. He continued to operate under ether, while he bided his time, waiting for a major operation before publishing his claims to a discovery that he well realized would revolutionize surgery and startle the world. Long thus succinctly gives his motives:

Why Long Did Not Publish His Discovery

"I was anxious, before making my publication, to try etherization in a sufficient number of cases to satisfy my mind fully that anæsthesia was produced by the ether, and was not the effect of the imagination or owing to any peculiar insusceptibility to pain in the persons experimented on.

"At the time I was experimenting with ether there were physicians high in authority and of justly distinguished character who were the advocates of mesmerism and recommended the induction of the mesmeric state as adequate to prevent pain in surgical operations. Notwithstanding that it was thus sanctioned, I was an unbeliever in the science, and of the opinion that if the

mesmeric state could be produced at all it was only on those of strong imaginations and weak minds, and was to be ascribed solely to the workings of the patient's imagination. Entertaining this opinion, I was the more particular in my experiments in etherization.

"Surgical operations are not of frequent occurence in a country practice and especially in the practice of a young physician, yet I was fortunate enough to meet with two cases in which I could satisfactorily test the anæsthetic power of ether. From one of these patients I removed three tumors the same day; the inhalation of ether was used only in the second operation, and was effectual in preventing pain, while the patient suffered severely from the extirpation of the other tumors. In the other case I amputated two fingers of a negro boy; the boy was etherized during one amputation and not during the other; he suffered from one operation and was insensible during the other.

"After fully satisfying myself of the power of ether to produce anæsthesia, I was desirous of administering it in a severer surgical operation than any I had performed. In my practice, prior to the published account of the use of ether as an anæsthetic, I had no opportunity of experimenting with it in a capital operation, my cases being confined to small tumors and the amputation of fingers and toes.

"While cautiously experimenting with ether, as cases occurred, with a view of fully testing its anæsthetic powers and its applicability to severe as well as minor surgical operations, others more favorably situated engaged in similar experiments, and consequently the publication of etherization did not 'bide my time.'"

Proof of Dr. Long's Claims

But are Long's documents genuine, complete and convincing? I can personally testify that they are. In 1896, I chanced to meet Mrs. Fanny Long Taylor, who amazed me by saying that her father was the discoverer of anæsthesia. I had heard only of Morton, in whose honor, as the discoverer of anæsthesia, a great celebration was in preparation in Boston. I was thrilled when she said she could put Dr. Long's documentary proofs in my hands, and when a few days later I hurried through his time-stained papers, case histories, account books, affidavits from patients, attendants, physicians in his town and elsewhere in Georgia, all

of which furnished overwhelming proof of the originality of his discovery and his successful employment of ether to produce complete anæsthesia in numerous operations, I asked permission to present his claims again in greater detail.

By happy fortune, I found one of Dr. Long's assistants still alive, and he (Dr. J. F. Groves) described Dr. Long's methods as follows: "Dr. Long poured ether on a towel and held it to the nose and mouth . . . and determined when the patient was sufficiently etherized to begin operation, by pinching him. Then he gave me the towel, and I kept up the influence by holding it still to the patient's nose. The patient was entirely unconscious."

Jackson and Morton united in claiming the discovery in 1846, Morton admitting that he got the idea from Jackson and together they obtained a patent for their discovery, the nature of the anæsthesia, which they called letheon, being kept secret. Wells then came forth with his claim of having used nitrous oxide in 1844. Morton and Jackson subsequently fell out, and Dr. Jackson, hearing of Long's claims, visited him in Georgia to investigate them and then generously wrote as follows:

Boston, April 11, 1861.

To the Editors of The Boston Medical and Surgical Journal:

Messrs. Editors:—At the request of the Hon. Mr. Dawson, U. S. Senator from Georgia, on March 8, 1854, I called upon Dr. C. W. Long, of Athens, Ga. From the documents shown me by Dr. Long, it appears that he employed sulphuric ether as an anæsthetic agent:

1st, March 30, 1842, when he extirpated a small glandular tumor from the neck of James M. Venable, a boy in Jefferson,Ga., now dead.

2nd, July 3rd, 1842, in the amputation of the toe of a negro boy belonging to Mrs. Hemphill, of Jackson, Ga.

3rd, Sept. 9th, 1843, in extirpation of a tumor from the head of Mary Vincent, of Jackson, Ga.

4th, Jan.8th, 1845, in the amputation of a finger of a negro boy belonging to Ralph Bailey, of Jackson, Ga.

Copies of the letters and depositions proving these operations with ether were all shown me by Dr. Long.

I then called on Profs. Joseph and John Le Conte, then of the University of Georgia at Athens, and inquired if they knew

Dr. Long, and what his character was for truth and veracity. They both assured me that they knew him well, and that no one who knew him would doubt his word, and that he was an honorable man in all respects.

Subsequently, on revisiting Athens, Dr. Long showed me his folio journal, or account book, in which stand the following entries:

James Venable

March 30th, 1842, Ether and Excising Tumor	$2.00
May 13th, Sul. Ether	.25
June 6th, Excising Tumor	2.00

On the upper half of the same page, several charges for ether sold to the teacher of the Jefferson Academy are recorded, which ether Dr. Long told me was used by the teacher in exhibiting its exhilarating effects, and he said the boys used it for the same purpose in the academy. I observed that all these records bore the appearance of old and original entries in the book.

I have waited expecting Dr. Long to publish his statements and evidence in full, and, therefore, have not before published what I learned from him. He is a very modest, retiring man and not disposed to bring his claims before any but a medical or scientific tribunal.

Had he written me in season I would have presented his claims to the Academy of Sciences of France, but he allowed his case to go by default, and the Academy knew no more of his claims to the practical use of ether in surgical operations than I did.

CHARLES T. JACKSON, M.D.

Long's claims were, therefore, shown to rest on solid evidence. He had produced complete anæsthesia by ether, which he personally administered; and he had operated painlessly on several persons four years before any one else. He had kept his anæsthetic secret but had told fellow physicians of his town and state of his work. By strange coincidence Morton did not publish his epoch making cases, but it remained for one who had not even done the operations, Dr. H. J. Bigelow, to become his mouthpiece and advocate. The next years witnessed a sad spectacle of litigation and controversy between the rival New England claimants for a

bonus from Congress for the discovery of anæsthesia. In this Dr. Long took no part, but a presentation of his documents by Senator Dawson of Georgia promptly killed the bill to give Morton $100,000.

That the general usage of ether in surgery came after the surgeons of the Massachusetts General Hospital had operated on persons anæsthetized by Morton in October, 1846, no one will gainsay. But in this epoch-making discovery there is surely glory enough for all. No true friend of Long would try to belittle the great achievements of Morton and his surgical co-workers in Boston from which world-wide recognition of the possibility of surgical anæsthesia came.

Benefits to Surgery and Humanity

Before anæsthesia, only thirty-four patients a year were operated on at the Massachusetts General Hospital. In five years the number had tripled, and in fifty years the increase was a hundred fold.

In the surgical textbooks before 1842 one finds described only minor procedures and emergency operations. Within ten years the changes wrought were immense; splendid new conquests over disease by surgery were reported. The advance was rapid, but not until Pasteur's great work on spontaneous generation (1862) and diseases of silkworms in 1865 and Lister's announcement of his discovery of surgical antisepsis in 1867, was the capstone placed on Long's work of fifteen years before. Surgery was delivered from the horrors of pain and infection, and, like an animal freed from a black dungeon of despair, bounded forth into the pure light of science.

Disease, now explained by the germ theory, rapidly fell before one masterful research after another, while surgeons boldly went forth to conquer the hidden terrors of the abdomen, the chest and the brain, and every corner of the human organism was finally brought under the searching rays of scientific medicine.

Without the gift of anæsthesia, where would surgery be to-day? Accustomed as people are to behold with complacency the wonderful accomplishments of modern medicine and surgery, what a tumult would ensue were surgeons to revert again to the days of the great discoverer whose memory was celebrated in the unveiling of the splendid replica of Crawford Williamson Long.

NOTES OF THE CRAWFORD W. LONG MEMORIAL.

The Statuary Hall, in which the statue of Long was placed, occupies the space under the great dome of the Capitol Building at Washington. Up to 1857, it was the meeting place of the House of Representatives, and all visitors visit this part of the great structure. It divides the Senate from the House, and each of the 48 states, which go to make up the United States,is permitted to place two statues in the Hall, as representatives of their greatest citizens.

The statue was conceived by J. Massey Rhind, and carved from Georgia marble by James K. Watt. It is stated to be exquisitely beautiful and luminous in its virgin purity, the face perpetuating the spirit of the physician-anaesthetist seeking surcease from pain for suffering humanity. The statue was the gift of The Crawford W. Long Memorial Association.

Among those present were the daughters of Dr. Long, Mrs. Frances Long Taylor, and Miss Emma Long. Dr. Joseph Jacobs, pharmacist, once a clerk in the drug store of Dr. Long, also attended the unveiling. Mrs. Rebecca Felton, former Senator from Georgia, and who is now 91 years of age, insisted on being wheeled into the Hall that she might, "out of the fulness of her heart, voice the gratitude of all womenkind for pain relief in childbirth."

In the little town of Jefferson, Georgia, the first permanent memorial may be seen. It is a modest marble tablet, and reads :—On this spot Dr. Crawford W. Long, discoverer of ether, performed the first painless operation in surgery March 30th, 1842. In the centre of the old-fashioned public square of this miniature city in the foot-hills of the Blue Ridge Mountains, there is also a monument built in the form of the Washington Monument on the Potomac.

Popular legend has it that Dr. Long's first operation was performed under an old mulberry tree which stands directly north of the Monument. Souvenir hunters take small parts of this tree away, and numerous mementoes have been carved the most noted being a pen used by Woodrow Wilson in signing important documents.

Dr. Wm. Hamilton Long spoke as representative of the Southern Association of Anaesthetists.

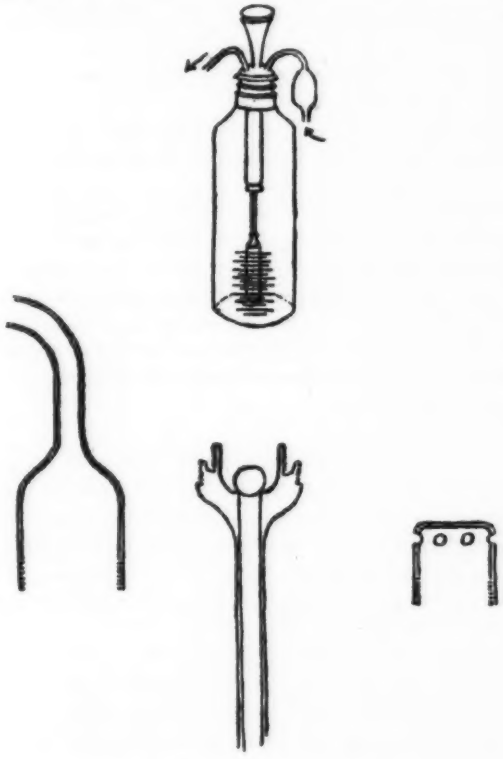
AN IMPROVED JUNKER'S INHALER.

H. G. Dodd, Hove.

Owing to the occurrence of several accidents, which have sometimes had fatal results, various methods have been devised of rendering Junker's Inhaler safer in use. Perhaps the best known of these is Rigby's device, consisting of a ball-valve fixed to the distal end of the afferent tube, which is turned upwards to open at a level considerably above the bottom of the bottle. In practice this has several disadvantages. At the commencement of the administration, chloroform is vapourised by pumping air *through* the liquid, but the distance between the valve outlet and the level of the fluid is insufficient to ensure saturation: whereas, when the bottle has become rather more than half empty, the air current no longer passes through but *over* the chloroform. Vapourisation by means of the "draw over" principle, to be effective, requires a relatively large surface of chloroform, and that afforded by a Buxton's bottle is totally insufficient for the purpose. Thus with this type of apparatus two different methods of vapourisation are employed during a single administration, neither of which, owing to the construction of the machine, can be regarded as really efficient. Moreover, a further difficulty presents itself to the anæsthetist who desires to use ether or a mixture containing ether. After quite a short interval the ether freezes, the small outlets above the valve become choked with ice, the ball-valve itself becomes frozen in its socket, and the pump is put out of action. This can of course be obviated by unscrewing and detaching the valve fitting altogether, but by so doing the whole object of the contrivance is frustrated.

The accompanying sketch shows how Junker's apparatus can be rendered safe without sacrificing its effectiveness. The inlet tube remains straight and runs down close to the bottom of Buxton's bottle, and its lower extremity is tipped with bone, or some other non-conductor of heat, precisely as obtains in the older models. The ball-valve is screwed to the afferent tube outside the bottle, close to the attachment of the rubber tubing from the hand bellows: by this arrangement the inhaler is rendered immune from

the disadvantages enumerated above. The instrument should be supplied equipped with a ball valve so situated as a standard fitting.



ETHER INHALER.

An Adjustable Outer Chamber for use in conjunction with an Open Ether Mask.

By R. Schaffer, B.Sc., M.B., Ch.B.

The apparatus provides for an improved and much more economical administration of ether by the "Open Method" and enables all the advantages of the "Closed Method" to be super-added.

By the Open Ether method a vapour strength of 12—14 per cent. is attainable, and whilst this is a safeguard against overdose in the hands of a beginner, it carries with it certain disadvantages. Chief amongst these is the difficulty in inducing anæsthesia and securing adequate muscular relaxation in powerful subjects. There is, in consequence, a tendency to resort to chloroform or chloroform mixtures, at a stage when their use is to be particularly deprecated. The necessary result can be attained by ether alone if provision be made for appropriate concentration of the ether vapour.

In the apparatus about to be described, the induction period is greatly shortened, adequate muscular relaxation is easily attainable, and the amount of ether used in each case is enormously reduced. The carbon dioxide in the patient's expired air is conserved and acts as a stimulus to breathing and prevents shock from acapnia. The chamber can be used in conjunction with the vapour method, or, if desired, be converted into a closed inhaler. Being adjustable, it is equally efficient whether the head be in the median or the lateral position.

Description of Apparatus.

The apparatus consistst of the following parts:—

1. An upper metal plate with a central aperture through which the ether is dripped. The aperture can be partially or completely closed by an adjustable cover.

2. A lower base plate made to fit accurately to an ordinary Schimmelbusch mask.

3. A system of tubular bellows attached above and below to the two plates. This enables the upper plate to be kept horizontal irrespective of the angle of the mask and base plate.

Slotted side-pieces and screws which allow of easy and rapid adjustment of the upper plate.

Anæsthesia is conducted as by the ordinary drop or vapour methods, and the appliance provides an efficient secondary chamber for the concentration of the ether vapour as desired, with appropriate conservation of carbon dioxide. The aperture being always at the top of the chamber, irrespective of the position of the patient's head, and ether vapour being $2\frac{1}{2}$ times as heavy as air, the vapour is retained by its own weight, and complete conservation can be obtained by closing the moveable cover.

Great economy is effected it the amount of ether used, for most

of the ether is actually utilised by the patient, and disemmination of the ether vapour into the atmosphere is reduced to a minimum.

The apparatus has been used with perfect success in powerful, muscular and alcoholic subjects in whom the open and semi-open methods had failed to produce adequate muscular relaxation.

Nitrous oxide and oxygen can be used in conjunction with the ether, if desired, by closing the top cover.

The bellows are easily detached and can be renewed if damaged.

ABSTRACTS OF CURRENT ANÆSTHETIC LITERATURE.

Albromin as a Substitute for Novocain. H. Olivecrona, Acta Chirurgica Scandinavica, lix, 552, 1926.

Olivecrana prefers this drug as a local anaesthetic in intercranial surgery for its more complete and prolonged anaesthesia. In 21 cases where albromin was used, analgesia was satisfactory, although he noted its incompleteness now and then when certain intercranial manipulations were necessary.

The dose ranged from 50 to 130 c.cm. of a half per cent. solution, and analgesia lasted as long as three or four hours. He observed no unfavourable reactions.

Anaesthesia of the Brachial Plexus. Henry W. S. Wright, The British Jl. of Surg., July, 1926.

Dr. Wright reports the results of 56 consecutive cases of Brachial Plexus Blocking performed by him at the Isinanfu, China Hospital, with novocain solution, to which he added adrenalin. Half-an-hour before the injection he administered scopolamine, grain one-hundredth and morphia, grain one-sixth. He emphasizes this time relationship because these two drugs combined occasionally produced over-reaction to the slightest stimulus and removed the patients self-control. Of the 56 cases, 50 results were perfect or satisfactory, 2 were indifferent, and 4 failures. In 5 cases ether was used and in six chloroform to produce sleep.

The method finds its most useful application for major operations about the elbow-joint and on the fore-arm.

Caesarean Section under Local Anaesthesia. D. K. Pillai, Caduceus, Hong Kong, May, 1926.

Dr. Pillai declares that in this type of case lumbar anaesthesia is not uniformally successful and nerve-blocking has variable results. 300 to

350 c.c. of ½ per cent. solution of novocain (with 2 to 4 minims of adrenalin hydrochloride, one to sixteen hundred, in 100 c.c. solution) is an ideal local anaesthetic, lasting 2½ hours, with no anaesthetic mortality.

The local anaesthesia is a direct local infiltration of the tissues and is not nerve-blocking as advocated by Brown.

Heart cases should not have the preliminary injection of morphia.

In doing this operation he states that the lower uterine segment, not the motor arsea, is incised, and a pair of obstetric forceps is necessary for the delivery of the head.

The Principle of Intratracheal Anaesthesia A. B. K. Watkins, *Med. Journ of Australia*, July 10, 1926.

The author emphasizes the fact that in order to render the anaesthetic so safe that the patient can go on breathing quietly and evenly and keep fit and have a good colour and be so immune from the dangers of inspiration that the nasal, pharyngeal and oral cavities may be completely filled with blood, pus or lotions without any danger, enough air must be supplied for there to be an excess of it passing up alongside the catheter towards the mouth during every phrase of the respiratory act.

To bring about this result he has devised a special rubber covered ambour which indicates negative pressure and which is connected to the patient's side of the apparatus. As long as the rubber covering remains distended, one need have no fear that the patient is not receiving enough air. The least retraction during any phrase of respiration indicates that a risk of inspiration of fluids exists and more air must be supplied.

He thinks that the inertia of the mercury in the ordinary mercury manometer is so great that negative pressure can exist for short times in the catheter without being indicated by the manometer.

Spinal Anaesthesia. MEREDITH F. CAMPBELL, *Annals of Surgery*, July, 1926.

At the Bellevue Hospital, New York, of 3668 urological operations during the past six years, 410 were performed under spinal anaesthesia. Comparing general and spinal anaesthesia, a difference of 4 per cent. mortality in favour of spinal anaesthesia was noted. Sacral and parasacral anaesthesia were used in 26 cases, in 4 of which it was necessary to use spinal also. Where the spinal was given between the third and fourth lumbar vertebrae occasionally it was found necessary to use novocain locally because the skin anaesthesia did not extend more than two inches above the symphysis.

In seven cases it was neccessary to administer a general anaesthetic; the spinal having proved unsatisfactory.